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Canadian Science Advisory Secretariat
Maritimes Region | Science Response 2014/024

INTERIM REPORT ON SCOTIAN SHELF SILVER HAKE (NAFO DIVS. 4VWX) STOCK STATUS

Context

The most recent assessment of Silver Hake (*Merluccius bilinearis*) was based on a framework assessment conducted in 2012 (DFO 2013). Through the framework process, a new analytical reconstruction of population trends was developed using a logistic biomass dynamic model, using commercial catch and Fisheries and Oceans Canada (DFO) research vessel (RV) survey data from 1992-2012. Biological reference points were calculated from model outputs and included Maximum Sustainable Yield (MSY), B_{MSY}, and F_{MSY}. The consequences and risk to productivity of the stock were evaluated under a number of harvest options (DFO 2013).

An interim update on the status of 4VWX Silver Hake was requested by the Resource Management Sector of Fisheries and Aquaculture Management Branch. The objective of the interim update is to report new information from the DFO summer RV survey, and commercial landings data. Following from this is an evaluation of recent trends in biomass (B) and fishing mortality (F) against MSY, B_{MSY}, and F_{MSY} derived in the framework assessment.

This Science Response Report results from the Science Response Process of February 27, 2014, on the Stock Status Update for Silver Hake on the Scotian Shelf (4VWX). Additional publications from this process will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

Background

Biology

Silver Hake is a demersal member of the gadoid family found from Cape Hatteras to the Grand Banks and the Gulf of St. Lawrence. A population of this species occurs on the Scotian Shelf in the Northwest Atlantic Fisheries Organization (NAFO) Divisions 4VWX management area. Silver Hake are found in warmer water, with hake juveniles and adults associated with water temperatures between 5–12°C and 7-10°C, respectively. A population of Silver Hake occurs on the Scotian Shelf in NAFO Divisions 4VWX. This population aggregates in deepwater depressions on the Scotian Shelf (Emerald and LaHave basins) and in the warm slope water, except during the spawning period from July-September when large aggregations occur on the shelf in shallow waters surrounding Emerald and Sable Island Banks. Silver Hake feed primarily on invertebrates, with euphausiids the predominant prey item. Older fish are piscivorous and exhibit a high degree of cannibalism. Silver Hake exhibit relatively rapid growth with females growing faster than males. Maximum age is 12 years. Maturity is relatively early, with a majority maturing at age 2. Further detail on Silver Hake biology is available in Stone et al. (2013).

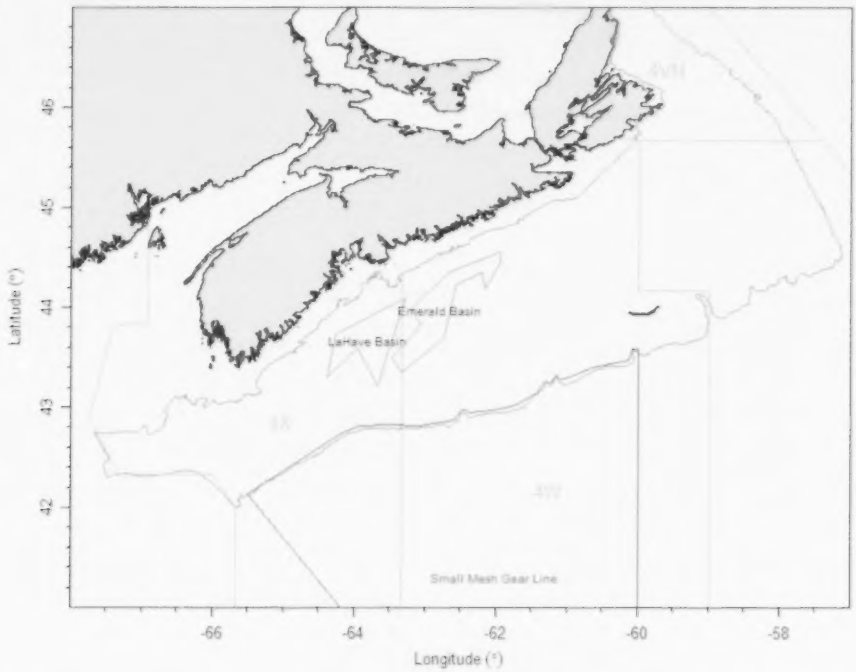

Figure 1. Management unit 4VWX. Silver Hake fishing is permitted in Emerald and Lahave Basins, as well as seaward of the Small Mesh Gear Line (blue line). The red outline represents the survey strata used to assess 4VWX Silver Hake.

Description of the Fishery

A significant fishery for Silver Hake on the Scotian Shelf (NAFO Div. 4VWX) began in the early 1960s with the arrival of the distant water fleets, predominated by Russia, Japan and Cuba from the 1960s to the early 1990s. Canadian participation in harvesting this species began in the mid-1990s and since 2004 all catches have been from the Canadian mobile gear fleet, predominantly in Emerald and LaHave basins using bottom trawls with 55 mm square mesh codends (Figure 1). Further details on the history of this fishery are available in Stone et al. (2013).

The Total Allowable Catch (TAC) has been set at 15,000 mt since 2003, but landings have been lower, averaging 11,000 mt for the years 2003-2012. Landings below the TAC do not appear to be related to abundance, but rather are a consequence of market conditions and reduced effort directed at this species. Landings of Silver Hake in the fishing years ending in 2011 and 2012 were 9,200 and 8,700 mt, respectively (Table 1, Figure 2). The 2013-2014 fishing season is still ongoing, and landings statistics are incomplete.

Table 1. Landings and TAC of Silver Hake in 4VWX ('000 mt)

Year	1970-79	1980-89	1990-99[2]	2000-04[3]	2005	2006	2007	2008	2009	2010	2011	2012	2013
TAC	90.2[4]	98.5	53.3	18	15	15	15	15	15	15	15	15	15
Canada[1]	0	0	3.7	14.3	11.8	12.3	12.0	12.1	10.4	8.4	9.2	8.7	
Foreign	115.6	64.2	27.8	0	0	0	0	0	0	0	0	0	
Total	115.6	64.2	31.5	14.3	11.8	12.3	12.0	12.1	10.4	8.4	9.2	8.7	

[1]. Includes developmental allocations fished by foreign flagged vessels, ending in 2004.
[2]. Fishing year, landings and TAC refer to the 15 month period from January 1, 1999 to March 31, 2000.
[3]. Commencing in 2000, fishing year, landings and TAC refer to the period from April 1st of the current year to March 31st of the following year.
[4] Averaged TAC for 1974-79 period.

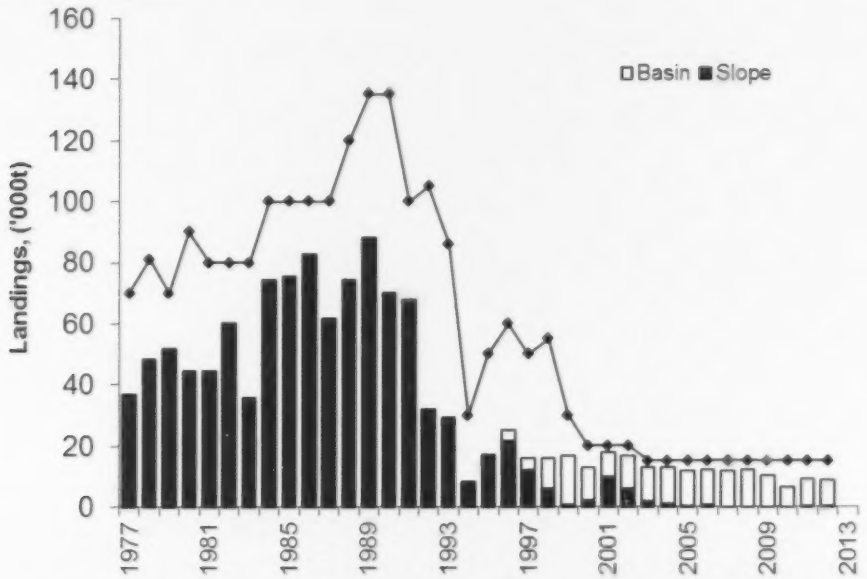

Figure 2. Silver Hake TAC and catches (000 mt) by fishing area, 1977-2012. Basin: landings from Emerald and LaHave basins. Slope: landings from the Scotian Shelf.

Analysis and Response

4VWX RV Survey

Since 1970, DFO has conducted bottom trawl surveys of the Scotian Shelf area using a stratified random sampling design for station locations. The longest running survey series covering the entire Silver Hake stock area is the DFO summer RV survey conducted in July (Stone et al. 2013).

The DFO summer RV survey provides important information on Silver Hake numbers and biomass, as well as estimates of year-class strength.

Silver Hake RV survey abundance and biomass were highest in the early 1980s, but declined from 1998 to 2008. Biomass increased from 2005-2011, with some declines seen in 2012 and 2013 (Figure 3).

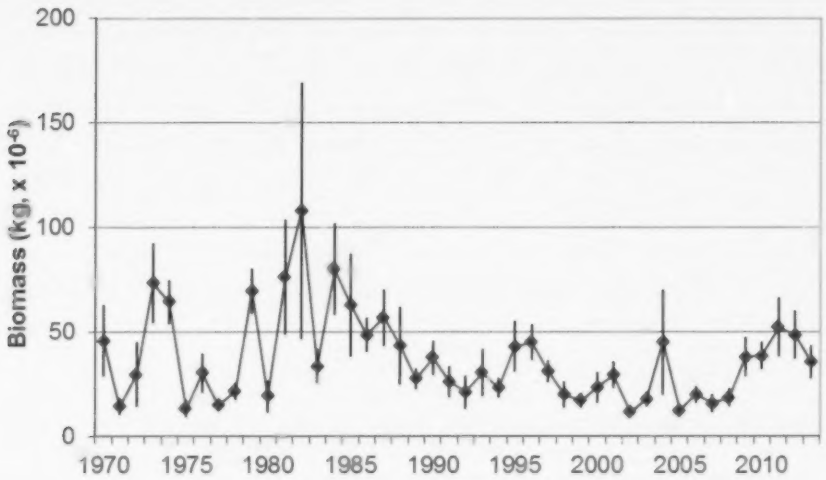

Figure 3. Stratified total biomass from the DFO summer RV survey for strata 440-483, 1970-2013. Vertical bars indicate 1 standard error.

While the 2012 and 2013 surveys have not been aged, the 2011 and 2012 year classes are present as distinct modes in length frequency data from the DFO summer RV survey. Total stratified numbers < 23 cm provides a proxy for age one numbers, and this is used as a recruitment index (Branton et al. 1997). Using this method, the 2011 year class is estimated to be above average, while that of 2012 is below average (Figure 4).

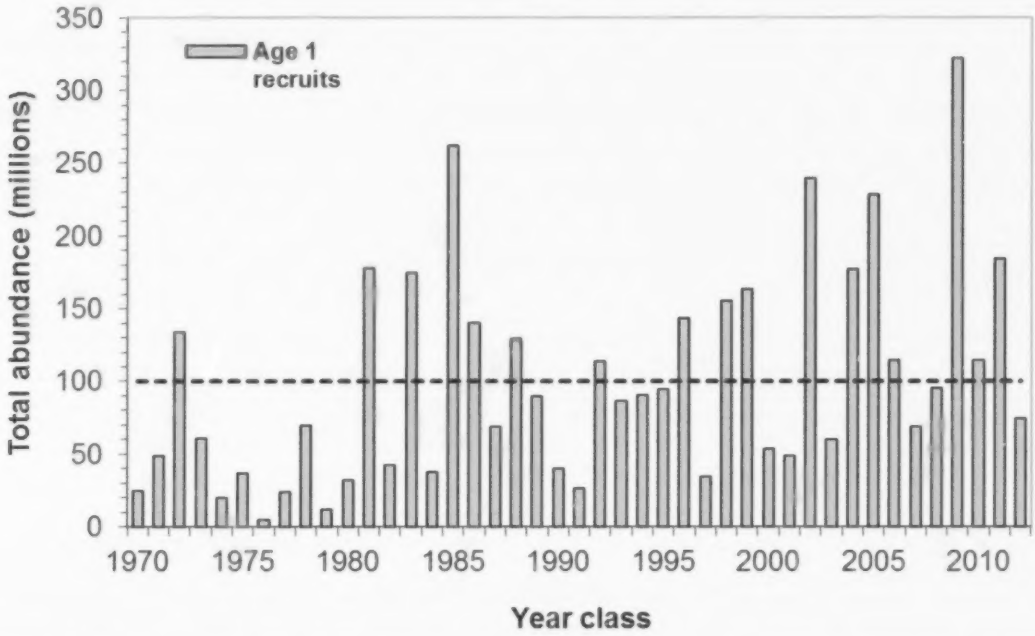

Figure 4. Recruitment estimates for Scotian Shelf Silver Hake from DFO summer RV survey abundance. The average for the series in indicated by the dashed line. 2011 and 2012 year classes are estimated from length data.

Population Modelling

In the 2012 framework assessment for this stock a logistic biomass dynamic model was accepted as a basis for estimating population biomass (Cook 2013). This model fits commercial fishery catches to the q-corrected summer RV survey index (1993-2012) to estimate trends in population biomass and fishing mortality.

The 2011 and 2012 biomass estimates from the model were the highest in the time series, at 123,000 mt and 120,000 mt, respectively. With the inclusion of the 2013 DFO summer RV survey abundance point in the model, the biomass estimate is lower, at 100,000 mt (Figure 5).

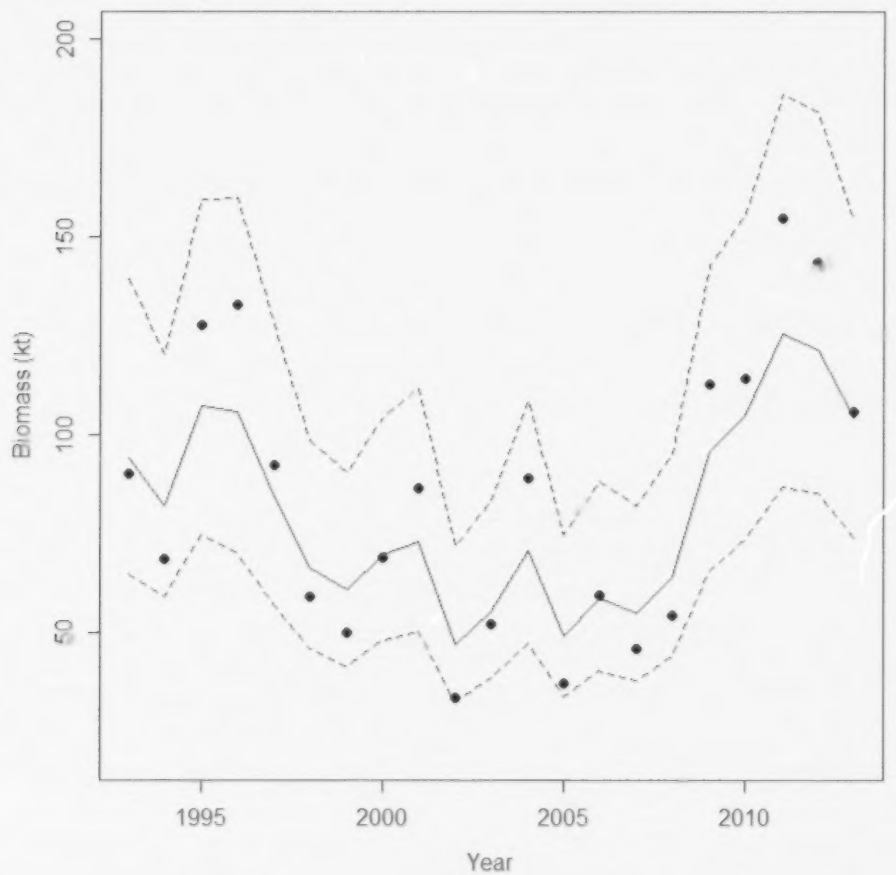

Figure 5.Scotian Shelf Silver Hake biomass estimates from logistic biomass model (solid line) and DFO summer RV survey data, 1993 – 2013 (black dots). Dashed lines represent 50% credible intervals for biomass estimates.

From the model MSY, biomass at MSY (B_{msy}) and fishing mortality at F_{MSY} were estimated to be 16,000 mt, 59,000 mt and 0.32 respectively. The Upper Stock Reference (80% B_{msy}) was 47,200 mt, and the Limit Reference Point (40% B_{msy}) 23,600 mt. F_{MSY} was taken as the limit Removal Reference (0.32).

Updated model results incorporating recent MARFIS landings until 2012 and the 2013 DFO summer RV survey are illustrated in Figure 6. The most recent stock status report projected an F of 0.08 with an estimated catch of 9,890 mt. (DFO 2013). Actual catches for this period were approximately 8,000 mt, with an estimated F of 0.064.

The relationship between stock biomass and exploitation (expressed as ratios of biomass and fishing mortality to B_{MSY} and F_{MSY} respectively) is presented in Figure 6. For the period covered by the model (1993-2013), biomass has been above 80% of B_{MSY} and fishing mortality has been below the reference level F_{MSY}.

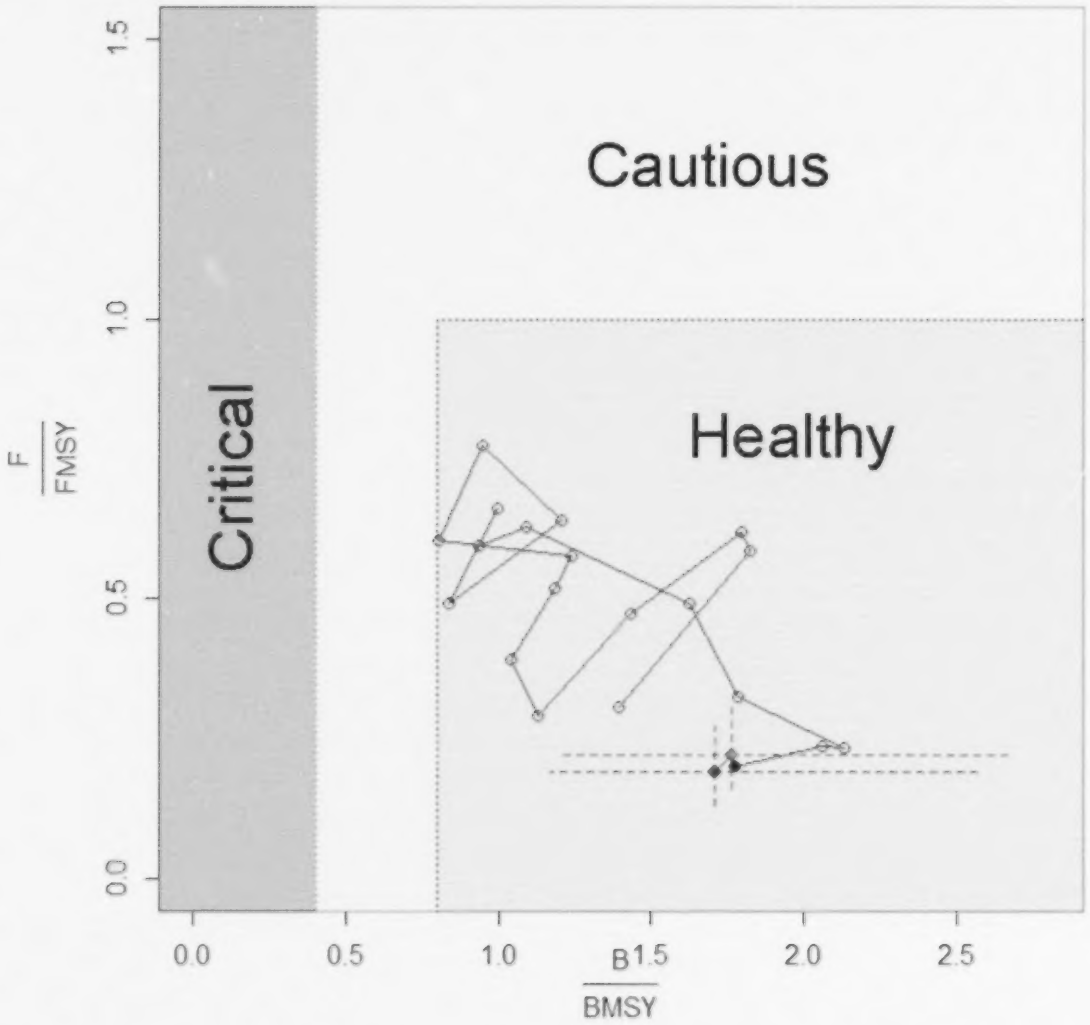

Figure 6. Phase plot of the ratio of fishing mortality (F) to F_{MSY}, and biomass (B) to B_{MSY}. Colours represent stock status: red-critical, yellow-cautious, green-healthy. The black dot represents the 2013 biomass and fishing mortality from the population model. The red diamond indicates projected biomass and exploitation with an assumed catch of 7,600 mt for the July 2013 to June 2014 period. The blue diamond represents projection at an assumed catch of 6,500 mt from July 2014 to March 2015 (partial year). The dashed lines are the credible 95% confidence intervals around the projected estimates.

As was the case in the previous assessment, a number of landing scenarios were explored, projecting biomass ahead for two periods – from July 2013 to June 2014 and from July 2014 to March 2015. From 2006 to 2011, 28% of landings were captured between April and June (DFO 2013). For 2014, catches were assumed to be 5.0 mt between July 2013 and March 2014 plus 28% of each landings scenario (i.e. to the end of June 2014; Table 2). Projecting for a partial

year from July 2014 to March 2015 assumed 72% of the total catch would be harvested during this period. (i.e. 72% of each scenario; Table 3). Recruitment was assumed to be the mean of the model time series.

Projected biomass and exploitation for 2014 and 2015 are shown in Figure 6.

Table 2. Results of different landing scenarios on projected biomass (x10 ^{3} mt) estimates, July 2013 to June 2014.

	Scenario ('000 mt)	Landings used for projections (July-June) ('000 mt)	Fishing Mortality	Median Biomass 2014 ('000 mt)	50%CI Biomass 2014 ('000 mt)	Probability of 2014 Biomass falling below X% of B_{MSY} Levels 80%	40%
TAC	9.1[†]	7.60	0.07	103	71-155	0.07	0.00
	12	8.50	0.08	102	70-154	0.07	0.00
	15	9.30	0.09	102	69-153	0.08	0.00
	18	10.20	0.10	101	69-152	0.08	0.00

[†] *9.1 mt is the 2009 – 2012 mean.*

Table 3. Results of different landing scenarios on projected biomass (x10 ^{3} mt) estimates, July 2014 to March 2015 (partial year).

	Scenario ('000 mt)	Landings used for projections (July-June) ('000 mt)	Fishing Mortality	Median Biomass 2015 ('000 mt)	50%CI Biomass 2015 ('000 mt)	Probability of 2015 Biomass falling below X% of B_{MSY} Levels 80%	40%
TAC	9.1[†]	6.52	0.06	100	68-149	0.10	0.02
	12	8.54	0.08	97	66-146	0.11	0.02
	15	10.68	0.11	95	63-143	0.12	0.02
	18	12.82	0.13	92	61-141	0.13	0.03

[†] *9.1 mt is the 2009 – 2012 mean.*

As was observed in the model results, biomass has declined since 2011 (Figure 5). Biomass is projected to decline in 2014 and further in 2015 for all catch scenarios. However, despite these declines population biomass is predicted to remain above the Upper Stock Reference level of 80% of B_{msy}, with the probability of falling below this threshold approximately 10% for catch scenarios up to 18,000 mt (Tables 2 and 3).

Conclusions

In the 2012 Framework assessment it was concluded that Scotian Shelf Silver Hake biomass was above the Upper Stock Reference, and that fishing mortality was below the Removal Reference. Since that assessment of this resource, new information is available from two sources: commercial landings data and the results of the July 2013 DFO summer RV survey.

Exploitation in 2013 was lower than projected from the 2012 assessment (DFO 2013) due to reduced catches.

While survey biomass declined in 2013, it still remains high relative to the time series.

The stock remains in the healthy zone, with biomass above the Upper Stock Reference, and fishing mortality likely below the Removal Reference.

The current TAC is appropriate given stock status, but biomass is expected to fall as the 2011 year-class diminishes over time and is replaced by the below average 2012 year-class.

Sources of Uncertainty

The stock boundary between the Scotian Shelf and Gulf of Maine Silver Hake stocks is imprecise. The Bay of Fundy area is excluded from the analysis of DFO summer RV survey data, but distribution of the two stocks may vary from year to year.

The model approach used is based on the entire stock area, excluding the Bay of Fundy (Strata 440-483), although the majority of the fishery is restricted to Emerald and LaHave basins. This may preclude exploitation as high as F_{MSY}

Projections from the population model assume mean recruitment and growth across the projected years. Given that Silver Hake have a variable recruitment pattern and the fishery is based on 1 and 2 year old fish, the ability of the model to project more than one year ahead is uncertain.

Contributors

Name	Affiliation
Mark Showell (Lead)	DFO Science, Maritimes
Adam Cook (Reviewer)	DFO Science, Maritimes
Steve Campana (Reviewer)	DFO Science, Maritimes
Heath Stone (Reviewer)	DFO Science, Maritimes (SABS)
Verna Docherty	DFO Fisheries and Aquaculture Management, Maritimes
Carl MacDonald	DFO Fisheries and Aquaculture Management, Maritimes
Lottie Bennett (Chair)	DFO Science, Maritimes (CSAM)
Christie Whelan	DFO Science, Maritimes (CSAM)

Approved by

Alain Vézina
Regional Director of Science, DFO Maritimes Region
Dartmouth, Nova Scotia
Ph. 902-426-3490
Date: March 4, 2014

Sources of Information

Branton, R, J. Black, and M. Showell. 1997. 1997 Summer Groundfish Survey update for selected Scotia-Fundy groundfish stocks, including a revised projection of silver hake catch using the survey estimate of the 1996 yearclass. DFO Atl. Fish. Res. Doc. 97/104. 52 p.

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Centre for Science Advice (CSA)
Maritimes Region
Fisheries and Oceans Canada
PO Box 1006, Station B203
Dartmouth, Nova Scotia
Canada B2Y 4A2

Telephone: 902 426-7070
Fax: 902 426-5435
E-Mail: XMARMRAP@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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